The TROBOT 4.0 – Assembly Guide
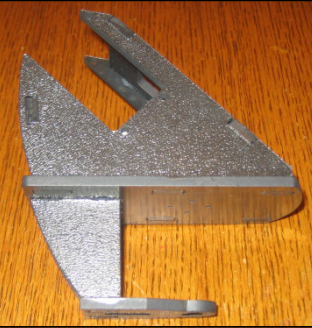

Thank you for supporting the development of the TROBOT 4.0 robot project. The TROBOT was designed to be a low-cost, functional, and educational robotics project. I hope you enjoy learning about robotics and adapting the TROBOT to a useful application.

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TROBOT 4.0 - Parts List:

Item #	Description	Qty	Image
1	Servo Axis 1 Base Assembly	1	
2	Servo Axis 2 Assembly	1	
3	Servo Axis 3 Assembly *Note: This part was revised during manufacturing. Some kits use both 6 & 8mm screws to attach to servo & idler.*	1	
4	Servo Axis 4 Assembly *Note: This part was revised during manufacturing. Some kits use both 6 & 8mm screws to attach to servo, spacer, & idler.*	1	
5	Servo Axis 5&6 Wrist Assembly & Cover	1	
24	Servo Wire Bracket	2	
25	0.080" Spacer	1	

6	¼" Aluminum Hub (with 10-32x1/4" set screw)	2	
7	¼" Precision Stainless Shaft, 6"	1	
8	¼" x ½" Ball Bearing	1	
9	20 awg stranded wire (black)	9 ft	
23	3/32" Heat Shrink Tubing	≈1 ft	

TROBOT 4.0 - Servo Pack: (from Trossen Robotics)

Item #	Description	Qty	Image
10	Dynamixel AX-12A servos	4	
11	Dynamixel RX-24F FRS-B-RX24	1	

12	Dynamixel RX-64 servo	1	
13	RX-64/EX-106+ HN05-I101 Idler Bearing Set	1	
14	RX-24F - HN07-I101 Idler Bearing Set	1	
15	Bioloid Frame F7	1	
16	Bioloid Frame F3	1	
17	SMPS2Dynamixel Adapter Item #: FRS-B-SMPS2DYNA	1	
18	3-Pin Dynamixel cable Qty 3 x 180mm	6	

19	4-Pin Dynamixel cable Qty 3 x 240mm	3	
20	M2 x 6mm Hex Socket Head Bolts	25	
21	M2 Nuts	50	
22	AX-12A Hub Assembly	1	

Screws/Fasteners:

	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6	TOTAL
5-40 x 3/8" SHCS					4		**4**
Plastic screws #1x 7/32"					3		**3**
Plastic screws #2 x 3/8"	4						**4**
M2 x 6mm, Pan Head			4				**8**
M2 x 8mm, Pan Head		4	4	4			**12**
M2 x 6mm, Flat Head	4				4		**8**
M2 x 8mm, Flat Head	4						**4**
M2 x 10mm, Flat Head*	4						**4**
M2 x 12mm, Flat Head				4			**4**
M2.5 x 6mm, Pan Head*		8					**8**
M2.5 x 10mm, Pan Head		8					**8**
M2.5 x 8mm, Flat Head*		8	8				**16**

* extra screws provided for variations & changes during manufacturing. In an effort to simplify assembly and reduce the different types of fasteners used, future versions will use mostly Flat Head and over-length screws wherever possible.

	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6	TOTAL
M2 x 6mm (Trossen Kit Supplied)				4	6	4	**14**
M2 Nuts (Trossen Kit Supplied)	8			8	6	4	**26**
M2.5 nuts (With RX Servos)		8	8				**16**

Screws/Fasteners: <mark>(All Flat-head Screws, Laser Rev B)</mark>

Due to part manufacturing process & design improvements future revisions will use all Flat Head screws. Extra screws are provided with all initial kits. Ideally you should use the shortest possible screw that securely attaches each servo. If the screws are too long in some cases they could scrape and gouge the servo or TROBOT parts.

	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6	TOTAL
5-40 x 3/8" SHCS					4		**4**
Plastic screws #1x 7/32"					3		**3**
Plastic screws #2 x 3/8"	4						**4**
M2 x 6mm, Flat Head			4				**4**
M2 x 8mm, Flat Head	12		4	4	4		**24**
M2 x 12mm, Flat Head				4			**4**
M2.5 x 6mm, Flat Head		8					**8**
M2.5 x 10mm, Flat Head		8	8				**16**

|	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6	TOTAL
M2 x 6mm (Trossen Kit Supplied)				4	6	4	**14**
M2 Nuts (Trossen Kit Supplied)	8			8	6	4	**26**
M2.5 nuts (With RX Servos)		8	8				**16**

Tools recommended:

- Small Phillips Head Screw Drivers
- Needle Nose Pliers
- Soldering Iron
- Solder
- Cable/Wire (Zip) Ties
- 3/32" Hex/Allen Wrench
- 2mm Hex/Allen Wrench
- 2.5mm Hex/Allen Wrench
- Mounting Screws (3" or longer, not included, see below)
- ¼-20 bolt, washer, & nuts (useful to press/pull bearing into axis 4)

*Note: It is recommended to power up and verify that the servos are in their
centered position. It is also a good idea to preprogram the Servo ID for each.*

TROBOT Assembly:

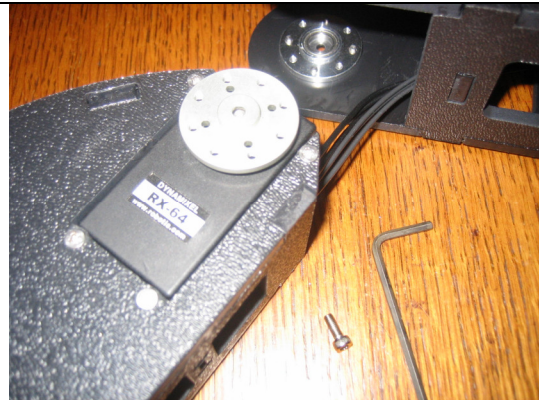|	

1. Prepare Axis 1 Base Assembly (Item 1)
 	
   a. Install AX-12 Servo (12) using Qty 4: M2x6mm Flat Head screws on the bottom & Qty 4: M2x8mm Flat Head screws on the top.
 	
   b. Set aside until later.
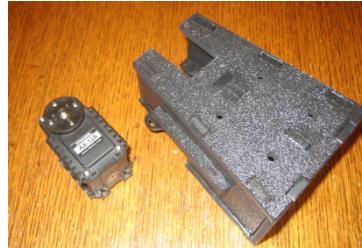 	
(Rev B – use Qty 8: M2x 8mm FH)	

2. Prepare Axis 2 assembly.
    a. Lengthen one of the 4 pin connectors (19) from 240mm (9.5 in) to 356mm (14 in).

    b. Lengthen one of the 3 pin connectors (18) from 180mm (7 in) to 560mm (22 in).

    Note: Splice in by soldering additional wire (9) and protect with heat shrink tubing (23). Be sure to not short or cross connect any of the wiring. If in doubt, only cut one wire at a time.

    c. Connect one end of the 4 pin cable to the lower side connector of the RX-64 servo. Feed the cable through the slots in the bottom of the Axis 2 assembly

    d. Connect a 240mm 4-pin cable to the connector on the other side and bring up the cable to pass through Axis 3 assembly.

    e. Install RX-64 Servo (12) using Qty8: M2.5x10mm (or longer) Flat Head screws.

    f. Set aside until later.

Note: Spacer used on RX-24/28 Idler only. Screws must not protrude through Idler Horn.

3. Prepare Axis 3 assembly

   a. Connect a 240mm 4-pin cable from the RX-24F servo down through the arm to the RX-64 servo (in the Axis 2 assembly).

   b. Install RX-24F Servo (11) using Qty 8: M2.5x8mm Flat head screws and nuts (provided with servo).

   c. Install Idler RX-64 Idler Bearing (13), onto bottom of Axis 3 Assembly using Qty 4: M2.5x6mm Pan Head screws.

   Note: This part was revised during manufacturing. Some kits use both 6 & 8mm screws to attach to servo and idler bearing.

   d. Feed the 3-pin cable completely through the Axis 3 assembly, and bring cable out through the back by the servo.

   e. Set aside until later.

4. Prepare Axis 4 assembly
   a. Lengthen one of the 3 pin connectors (18) from 180mm (7 in.) to 380mm (15 in).

   Note: Splice in by soldering additional wire (9) and protect with heat shrink tubing (23). Be sure to not short or cross connect any of the wiring. If in doubt, only cut one wire at a time.

   b. Install 1/4x1/2" Ball Bearing (8) into the end of the Axis 4 Assembly as shown.

   Hint: use a ¼-20 bolt, washers, & nut to press/pull the bearing into the hole. Make sure it is well seated and not misaligned.

   c. Install Idler RX-24 Idler Bearing (13) & Spacer (25), onto Axis 4 Assembly using Qty 4: M2x8mm Pan (or Flat Heads screws, if countersunk).
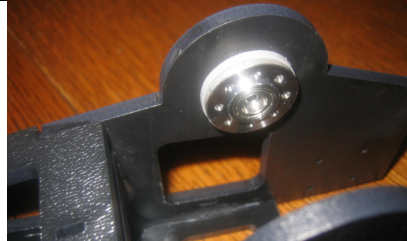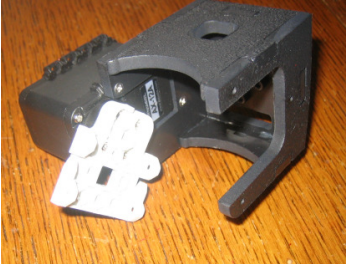   *(Rev B – use Qty 4: M2x 8mm FH)*

   d. Install AX-12 servo to plastic mount F3 frame (16) using Qty 8: M2x6 screws (20) and nuts (21) provided with Servo Kit.
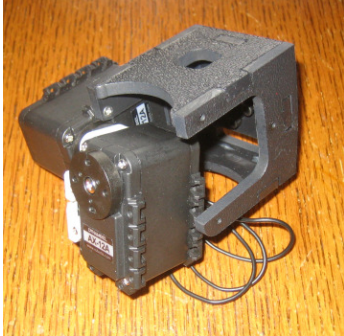
   Hint: A small amount hot melt glue will prevent the nuts from falling out while assembling.

   e. Mount a ¼"shaft coupling (6) to the AX-12 servo with Qty 4: M2x12mm Flat head screws as shown.
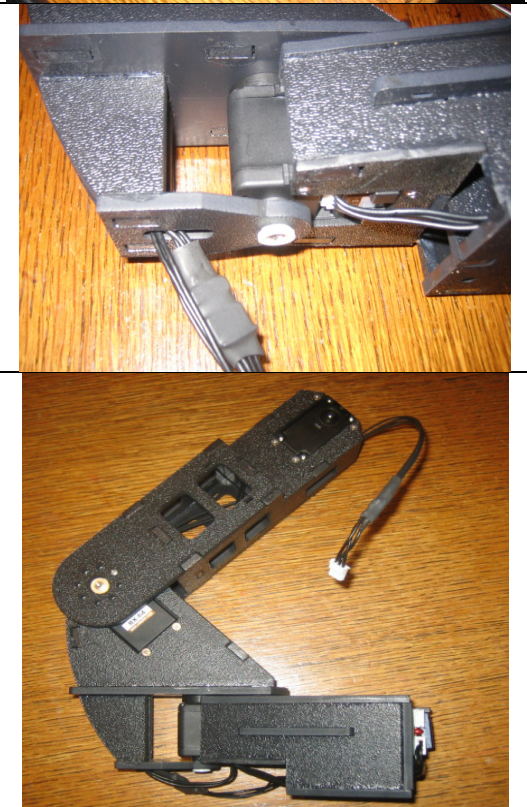
   f. Attach the ¼" precision shaft (7) to servo coupling and tighten the set screw to hold in place.

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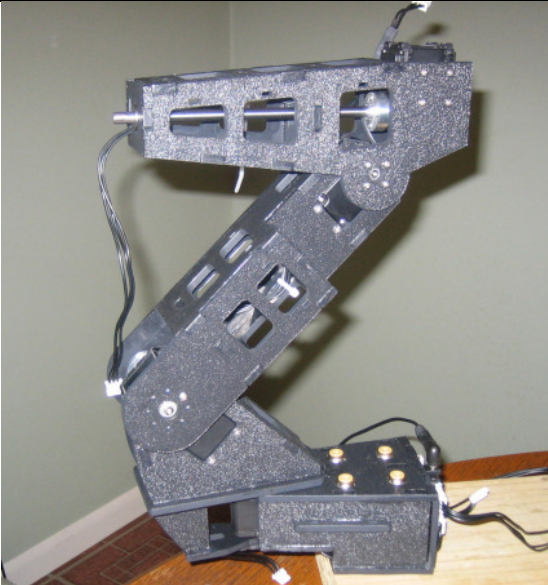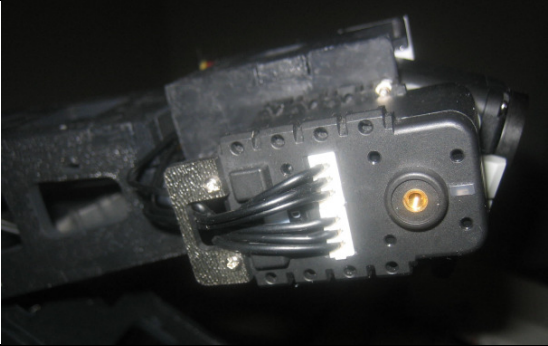
g. Slide the shaft through the bearing and mount the Axis 4 servo mount frame to the inside of the Axis 4 Assembly as shown. Use Qty 4: M2x8mm Pan head screws. h. Set aside until later. *(Rev B – use Qty 4: M2x 8mm FH & Qty 4: M2x 6mm FH)*	
5. Prepare Axis 5 & 6 (knuckle) assembly	
a. Install Set Screw hub onto back of Axis 5 assembly with Qty 4: 5-40x3/8" SHCS, verify that set screw is aimed towards the bottom, for easy access.	
b. Mount the Frame F7 (15) onto AX-12 servo (10) with Qty 4, M2x6mm screws (20). c. Install AX-12 Servo using Qty 4 - M2x6mm Flat Head screws. *(Rev B – use Qty 4: M2x 8mm FH)*	

6. Install the Axis 6 AX-12 servo using Qty 4, M2x6mm screws (20) and nuts (21).	
7. Install the SMPS2Dynamixel Adapter to the slot in the back of the Base Axis1 Assembly, with Qty 4: #2x3/8 Thread cutting screws	

8. Assemble the TROBOT components.
 	
    a. Attach the Axis 3 Assembly to the RX-64 Servo and idler bearing. REMOVE THE SERVO HORN SCREW before attempting to fit the assembly over the servo. Hold it in place and tighten the screw that attaches the idler bearing to the servo.
 	
    b. Attach the Axis 3* assembly to the RX-64 Servo Horn with Qty 4: M2.5x6mm Pan Head Screws.
 	
*Note: This part was revised during manufacturing. Some kits use both 6 & 8mm screws to attach to servo and bearing.
 	
Extra Screws provided in all kits. Make certain that the screw is not too long that it gouges/scrapes the servo.

c. Attach the Axis 2 assembly to the base with Qty 4: M2x8mm Pan Head Screws. *(Rev B – use Qty 4: M2x 8mm FH)*	
d. Attach the cantilevered bottom of the Axis 2 assembly with the AX12 Hub and screw (22).	
e. Install Axis 4 Assembly over the RX-24F servo in the same manner as Axis 3. Remove the Servo horn screw before assembling. Use Qty 4: M2x6mm Pan Head Screws to secure the assembly to the servo. *(Rev B – use Qty 4: M2x 8mm FH)*	

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f. Install the Axis 5/6 knuckle assembly over the ¼" shaft. g. Loosely loop the 3 pin wire around the Set Screw Coupling, so that the Axis 4 servo can rotate the full +/- 150 degrees. h. Verify that the servo is centered and tighten the Set screw. i. Install Axis 5 cover plate with Qty 3: #1x3/16" self-tapping screws.	
j. Clean up wiring with cable zip ties and use the Servo wire brackets to manage the motion of the wires.	

Congratulations! You're TROBOT 4.0 Kit is assembled!	

Mounting

The TROBOT 4.0 has 4 mounting holes to securely mount it. The holes are spaced at 1.25" inches square. The center of axis 1 rotation is also shown. It may be useful to drill an access hole through the material that the TROBOT base is mounted to. Mounting screws should go through the base assembly to secure the TROBOT.
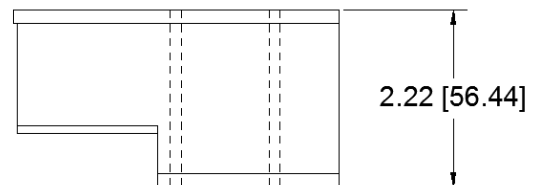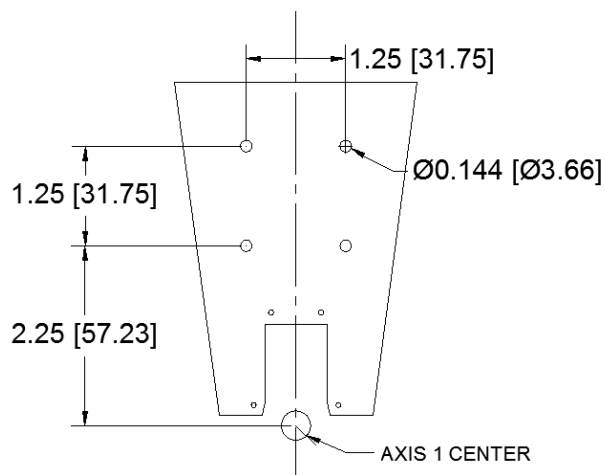
Servo Setup: (this section is still in progress)

Dynanixel servos have many features that ordinary hobby servos lack. They are intelligent which leaves the main processor free for other tasks. For example, you can read the actual position, speed, & torque of each motor. You simply set the desired position and speed and the servo handles the rest. You can also set acceleration ramp rates and 'In-range' margin for each servo, allowing them to be better tuned for a specific application.

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This TROBOT 4.0 uses a combination of AX & RX series servos. The parameters for both series are the same but the communication interface is different for each. The AX servos use a 3-pin connector and all data is transmitted and received over a single TTL level communication pin. The RX-series use RS485 Asynchronous Serial Communication Setup as 8bit, 1stop, No Parity. Both use a 'Multi-Drop, Daisy chained' connection. The TROBOT requires a dual UART interface to … (more later)

All Dynamixel servos come factory set to an address of '1'. Each servo should be individually powered up and the ID reset to the appropriate axis number.

The default baud rates between AX and RX series servos are different from the factory as well.

There are also a number of other parameters that should be setup as well.

CW & CCW Servo limits should be set for each axis to prevent a servo from trying to move too far in either direction.

Axis 2 & 3 Accelerations (Compliance Slope) should adjusted to better 'smooth' the robot motion.

Axis 2 & 3 Maximum speed (Moving Speed) should also be reduced.

Dynamixel Servo Support and Info: http://support.robotis.com/en/

Below is a table of recommended settings for each servo:

Recommended Initial Dynamixel Servo Settings						
TROBOT Axis Number	1	2	3	4	5	6
Servo Type	AX-12A	RX-64	RX-24F	AX-12A	AX-12A	AX-12A
Servo ID setting (0x03)	1	2	3	4	5	6
Baud Rate (0x04)	34	34	34	34	34	34
CW Angle Limit (0x06 word)*	184	330	350	0	280	0
CCW Angle Limit (0x08 word)*	840	880	650	1023	950	1023
Moving Speed (0x32 word)		80	80			
CW Compliance Slope (0x28 word)		128	128			
CCW Compliance Slope (0x29 word)		128	128			
xxxxxxxxxxxxxxx (0x00 word)						

* Some servos can be installed in one of two orientations, if so your Angle Limits could be different.